


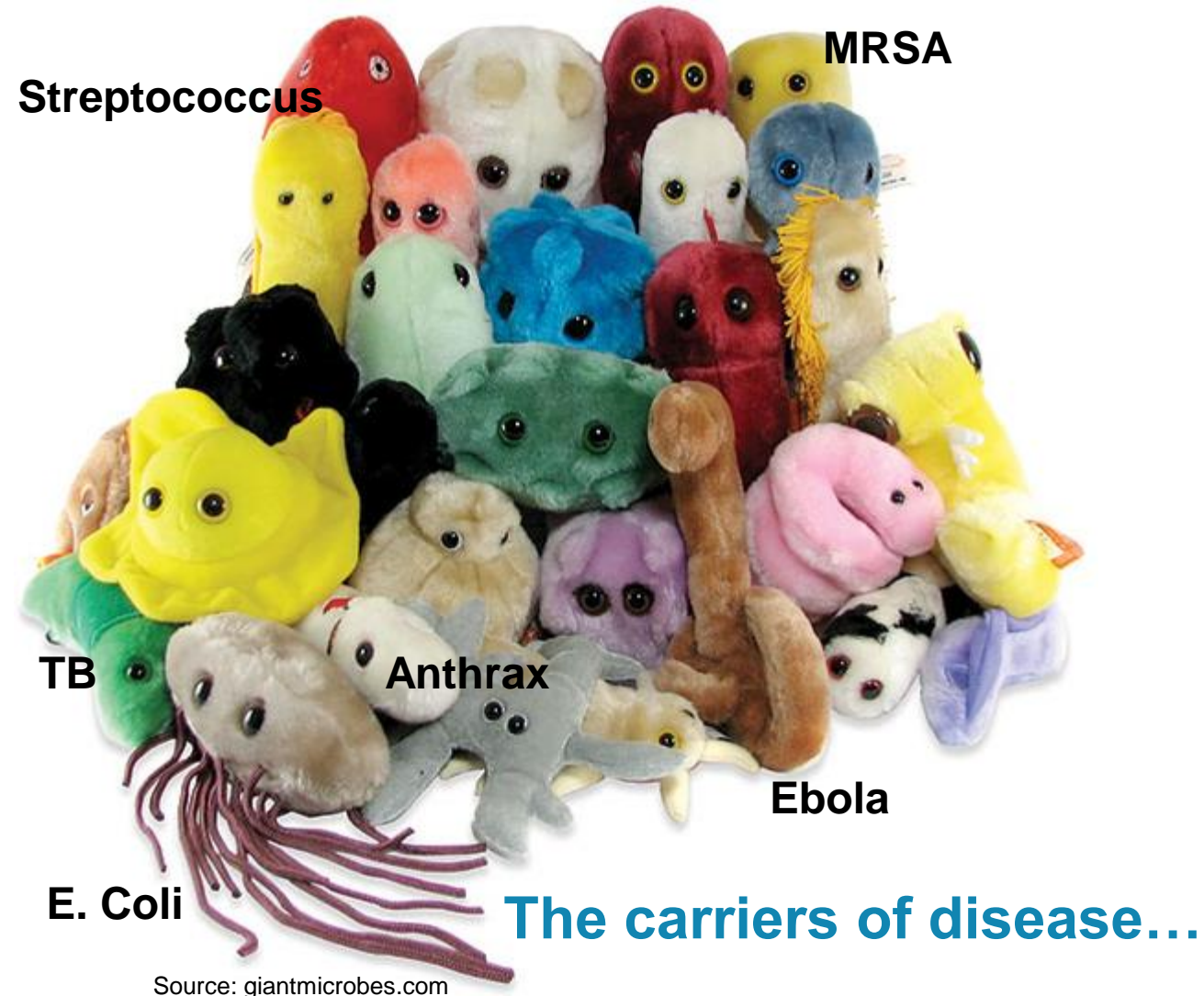
Started from the bottom now we're here: ***From synthetic biology to energy-relevant materials***

Victoria Chernow, ARPA-E Fellow

ARPA-E Energy Innovation Summit
March 13th, 2018



Microbes: the Good, the Bad, and the Ugly

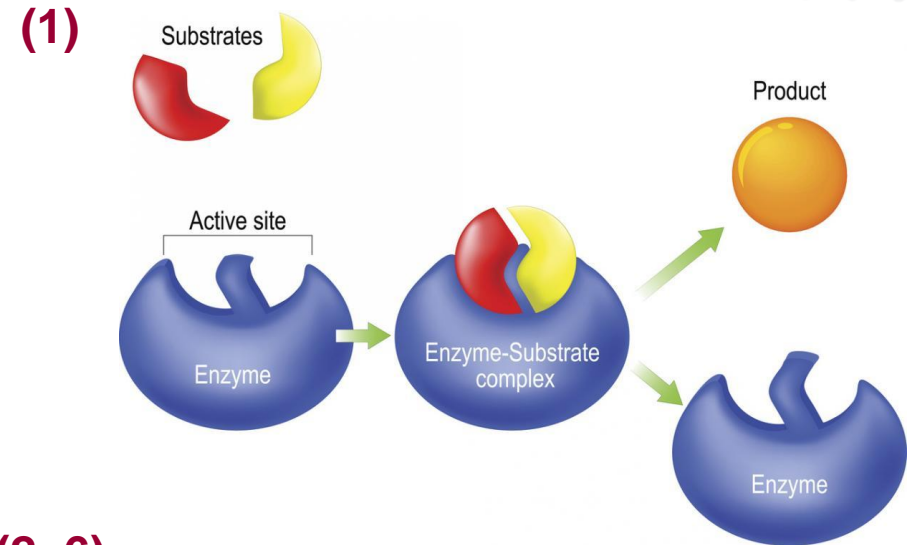


...and makers of gourmet treats.

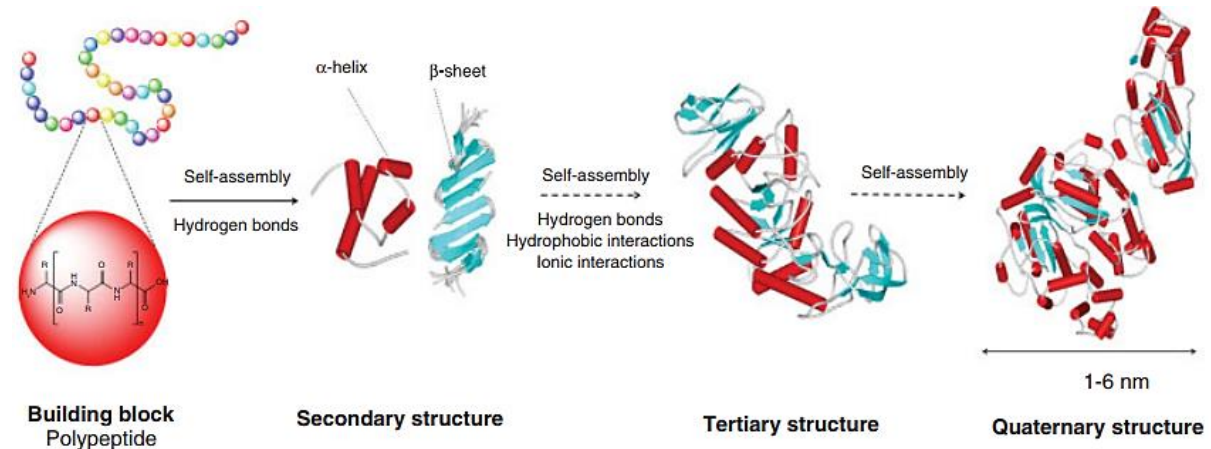


Vast Biological Capabilities

1. Catalytic capability
2. Materials synthesis with nanoscale precision
3. CO₂ fixation & energy harvesting
4. Redox reaction of metals
5. Self-replication & self-repair
6. Complex self-assembly

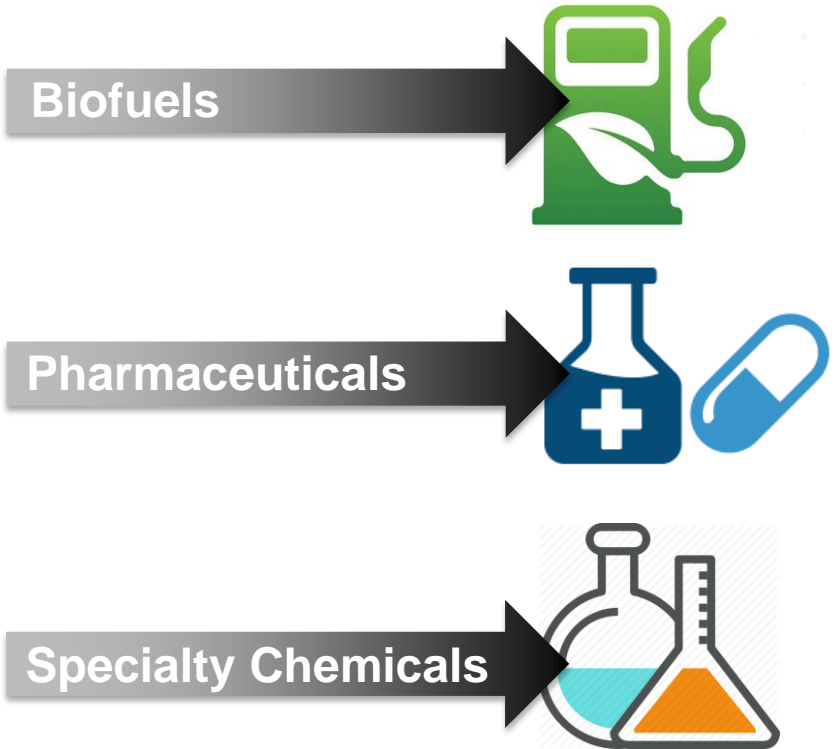
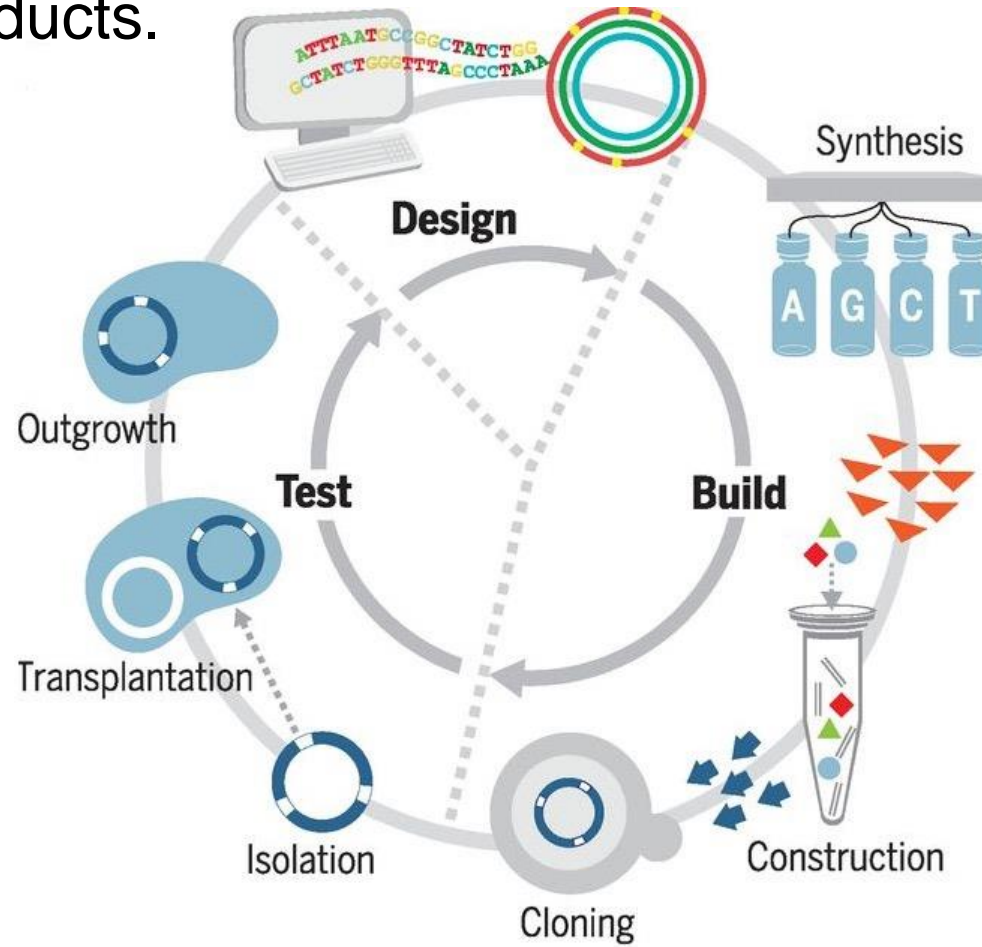


(2, 6)




Engineering the “Cell Factory”

Synthetic Biology allows for unprecedented control over cellular mechanisms and cellular products.



Commercialized Syn. Bio. Products



Can **synthetic biology** help us generate **materials**, **structures**, and **processes** that were previously thought impractical or even impossible with biology?

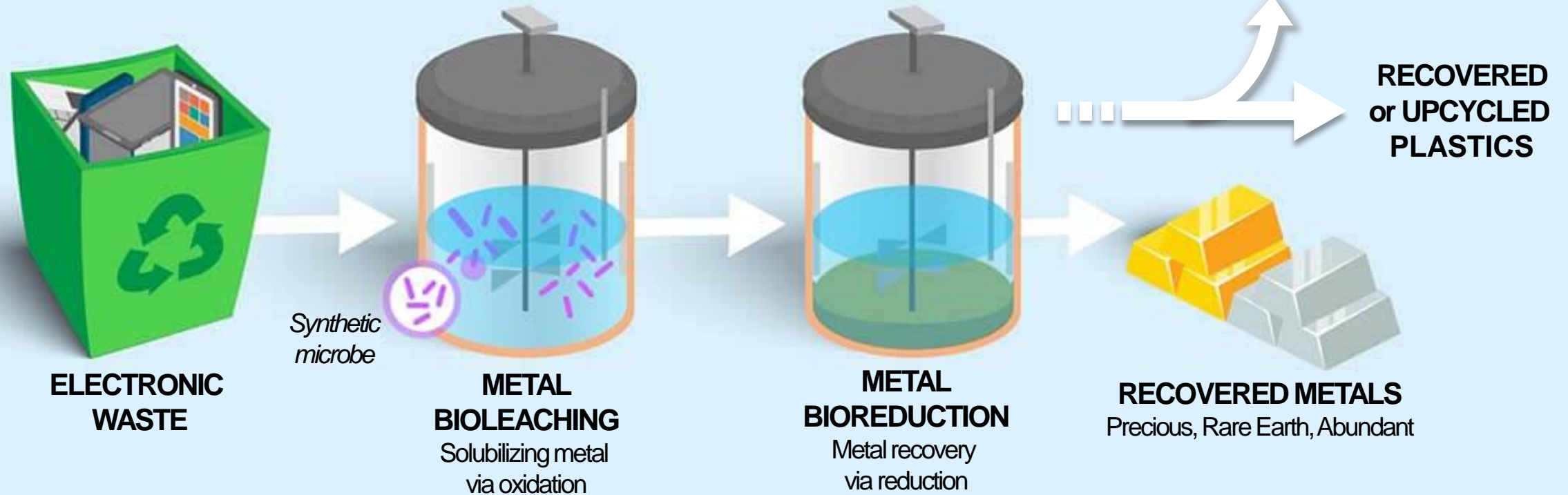
The US produced 6.3 million metric tons of electronic waste in 2016.
80% of e-waste is discarded in landfills or incinerated.

Recovering the metal from 100,000 phones would yield 5.3 pounds of gold, >1,984 pounds of copper, 55 pounds of silver.

Synthetic Biology to Enable New Processes

Opportunity: Can we make recycling waste electronic materials practical?

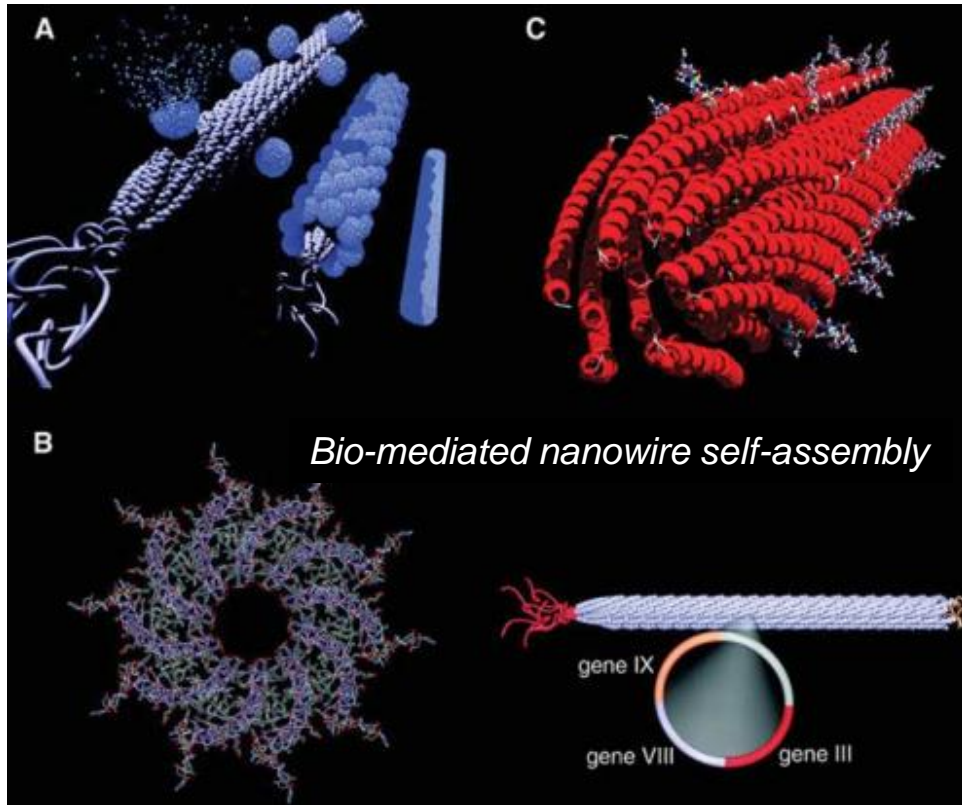
USING SYNETHIC BIOLOGY TO RECOVER MATERIALS FROM ELECTRONIC WASTE



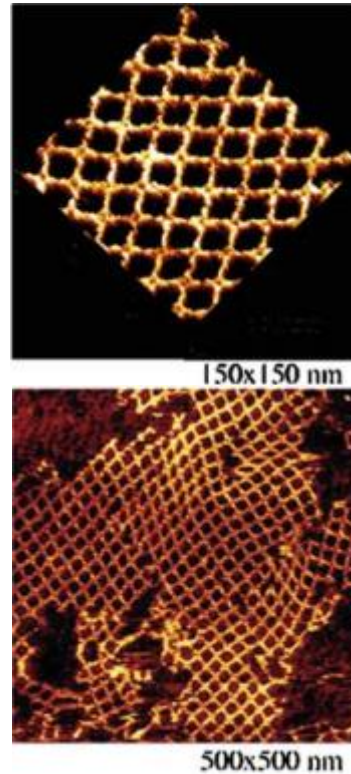
<http://news.nus.edu.sg/highlights/recovering-precious-metals-e-waste>

Synthetic Biology Enables New Devices

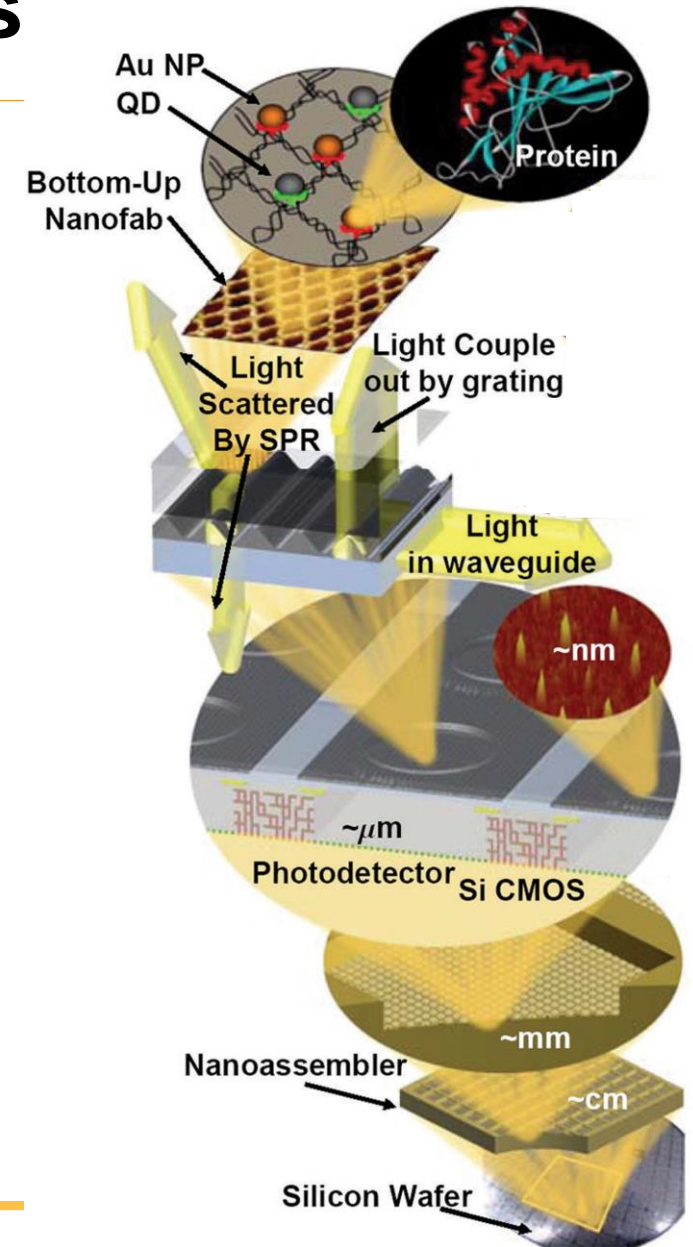
Nanoscale manufacturing precision and self-assembly:



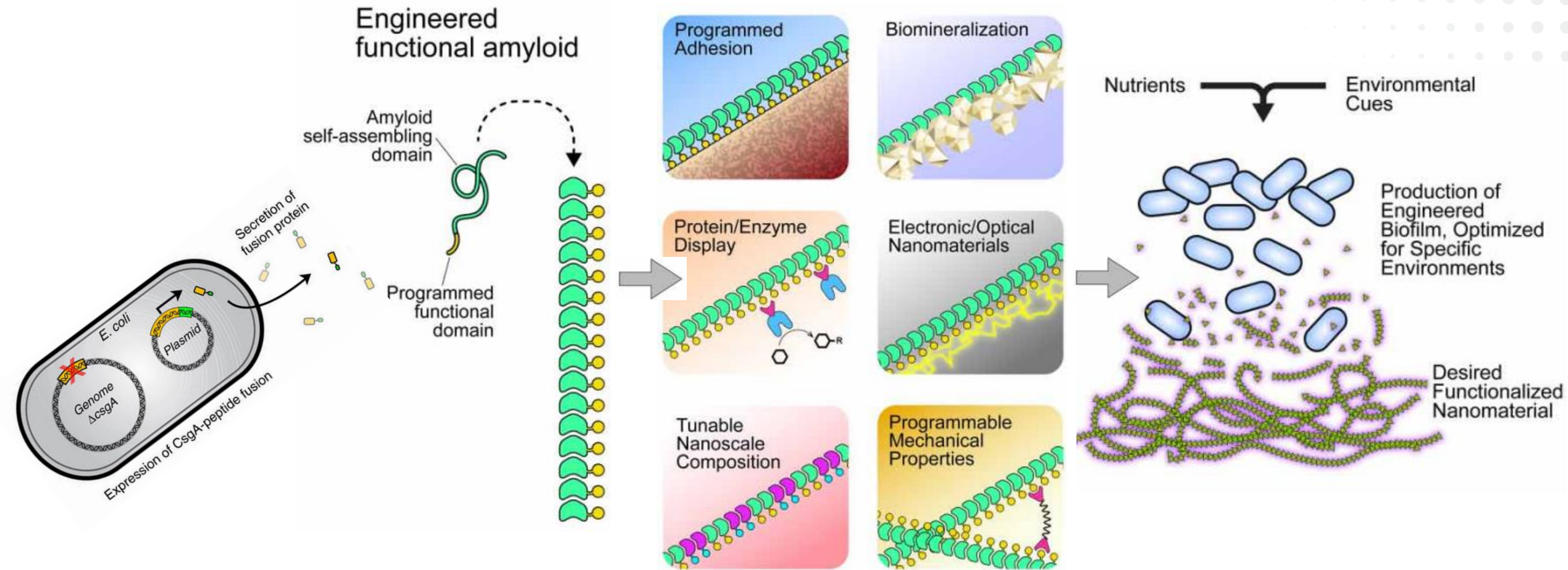
DNA Lattices



Opportunity: Can we make complex, self-repairing, nanodevices outside an energy intensive cleanroom?

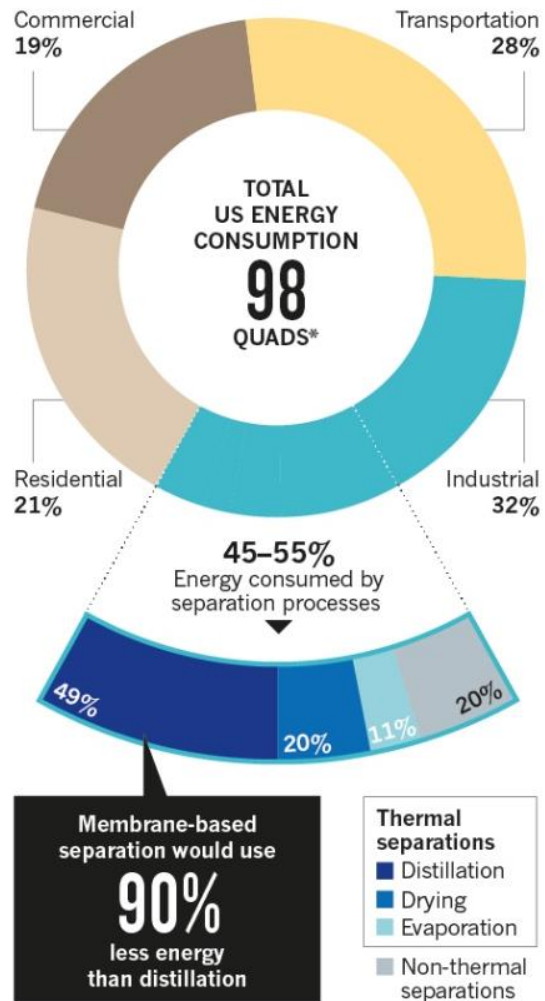


Synthetic Biology Enables New Materials and Structures



Opportunity: Can we make ultra-cheap, high performance, tailored membranes?

Opportunities in Membrane-based Separations



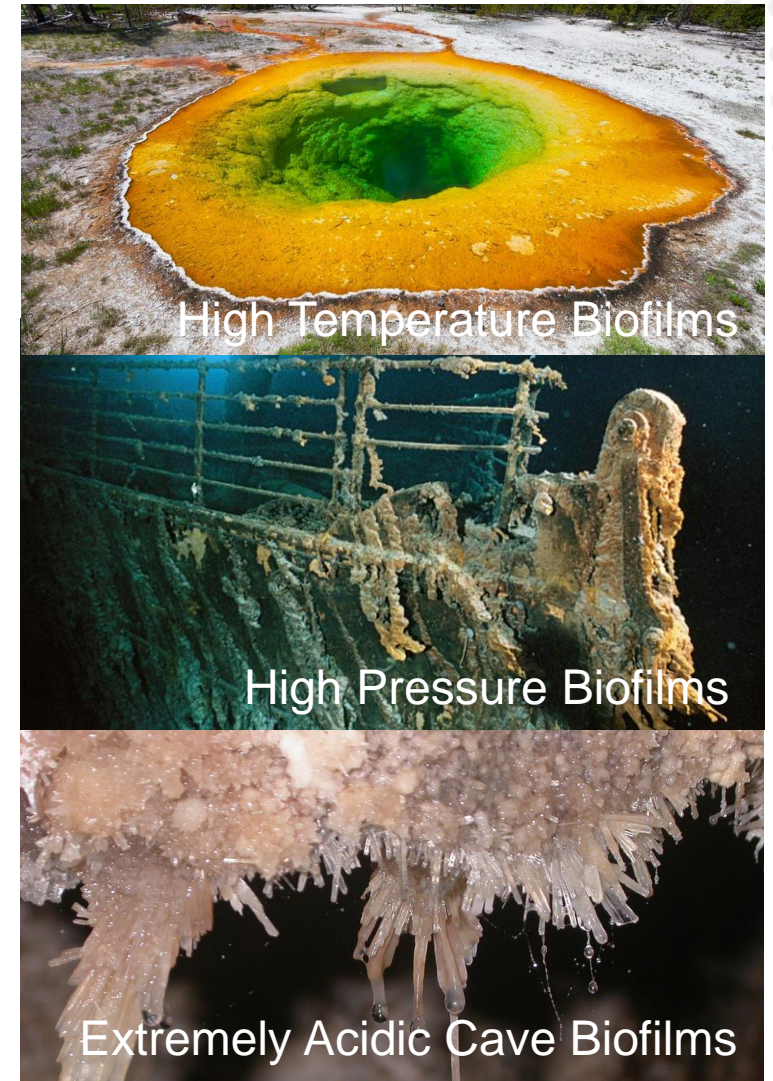
*A quad is a unit of energy equal to 10^{15} British Thermal Units (1 BTU is about 0.0003 kilowatt-hours).

©nature

- Separation processes account for 16% of total U.S. energy consumption.
- Half of separations is distillation.
- 90% energy savings by replacing distillation with membrane-based separation → **7 Quads saved**

Barriers for membrane use:

- High cost
- Tolerance of harsh conditions (T, P, pH)
- Fouling
- Poor Selectivity



What breakthroughs need to happen?

What innovations are necessary for synthetic biology to produce materials, structures, and processes:

- (1) with superior performance?
- (2) at minimal cost?
- (3) with marginal energy input?

Your feedback is key!

Victoria.Chernow@hq.doe.gov